US Army Corps of Engineers
Waterways Experiment Station

Dredging Research

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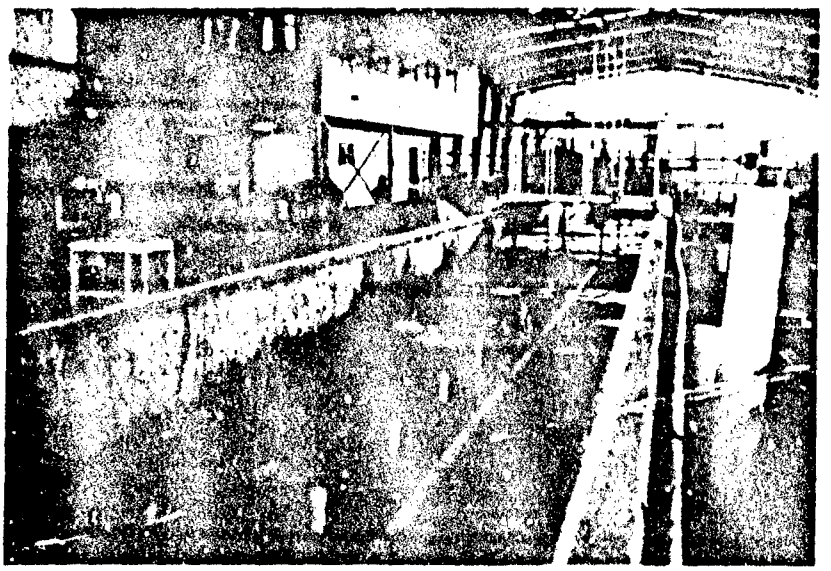
Nearshore berm testing at SUPERTANK

by
Cheryl Burke Pollock



Wave flume and typical instrument arrangement of a SUPERTANK experiment at Oregon State University

Controlled data sets for evaluating submerged nearshore berms are almost nonexistent. Through the Dredging Research Program (DRP), the U.S. Army Corps of Engineers is investigating the use of nearshore berms to place dredged material in the littoral system and provide wave attenuation in the berm's lee. Monitoring at some prototype sites has provided good overall information for this investigation but lacks the detail needed to develop more sophisticated design guidance.

As one element of the SUPERTANK Laboratory Data Collection Project, the United States' first prototype-scale, moveable-bed, physical model study of submerged nearshore berms was conducted in 1991. The overall SUPERTANK experiment was a cooperative effort among many interests, including Technical Area 1 (Analysis of Dredged Material Placed in Open Water) and Technical Area 5 (Management of Dredging Projects) of the DRP.

The DRP's Open-water Disposal Site Management work unit (under Technical Area 5) was responsible for the berm portion of the experiment. The objectives of the experiment were to look at the effect of the waves on the berm, the effect of the berm on the waves, and their combined effect on the beach.

Two initial berm configurations were constructed — narrow-crested and broad-crested. As wave activity reworked the berm material, other berm profiles were formed. Periodic bathymetry profiles portray the evolution of the berm and the beach profile. Dense instrumentation monitored the hydrodynamics along the length of the flume.

Information gained from this experiment will aid in the design and placement of nearshore berms and the prediction of benefits of wave attenuation and sheltering effects, berm contour evolution, and fate of the placed material. Additionally, data from this experiment can be used to develop and calibrate numerical models used for designing and

evaluating benefits of nearshore berms.

Laboratory data collection project

The SUPERTANK Laboratory Data Collection Project was performed at Oregon State University's Large Wave Flume during July through September 1991 (Kraus, Smith, and Sollitt 1992, Kraus and others 1992). The flume measured 104 meters long, 3.7 meters wide, and 4.6 meters deep. Approximately 600 cubic meters of uniform-size quartz sand of 0.26-millimeter median diameter was placed in the flume to form the beach and nearshore.

The focus of SUPERTANK was to obtain comprehensive data on beach erosion and recovery, surf zone waves and currents, bottom boundary layer fluid, and sediment transport processes. In addition to the submerged nearshore berm experiments, testing included beaches with a wide berm, a seawall, a dune, and combinations of these features.

Wave height and period and the water level were varied to produce different hydrodynamic and sediment transport conditions and corresponding beach profile evolution. Periodic surveying of the profile was performed from a moving carriage along three transects parallel to the flume axis.

Instruments used to monitor hydrodynamic and sediment concentration for the submerged nearshore berm experiments included 19 electromagnetic current meters, 17 resistance-type wave gauges mounted in the offshore and surf zone supplemented by 10 mobile capacitance-type wave gauges in the swash zone and 34 optical back-scatterance sensors. Three video cameras taped wave breaking over the berm, the surf zone, and the swash zone during the experiment.

Submerged nearshore berm test

The submerged nearshore berm tests were conducted during the last operating week at SUPERTANK. The objective of these tests was to evaluate various berm geometries. The features were constructed by placing approximately 150 cubic meters of additional sand through the water column, achieving a 1 vertical on 5 horizontal side slope. The initial beach profile was similar to profiles of previous SUPERTANK tests. Water levels were held constant at 5 feet throughout the tests. The initial berm of the narrow-crested berm experiments crested at -6.5 feet (with reference to the datum) and was centered between stations 11 and 15, nearly 150 feet offshore (Figure 1). Crest width of the berm measured 6 feet. The initial berm of the broad-crested berm experiments also crested at -6.5 feet, but its crest width was nearly 30 feet (Figure 2). The berm was centered between stations 11 and 17.

Waves attacked the constructed profiles for five days. Wave conditions selected for testing correlated with previous SUPERTANK wave runs on similar beach profiles without a nearshore berm in place. Four wave conditions were selected, and wave events are listed in Tables 1 and 2. Wave sequencing began with irregular erosional waves followed by irregular accretionary waves, and then monochromatic erosional waves followed by monochromatic accretionary waves. This sequence

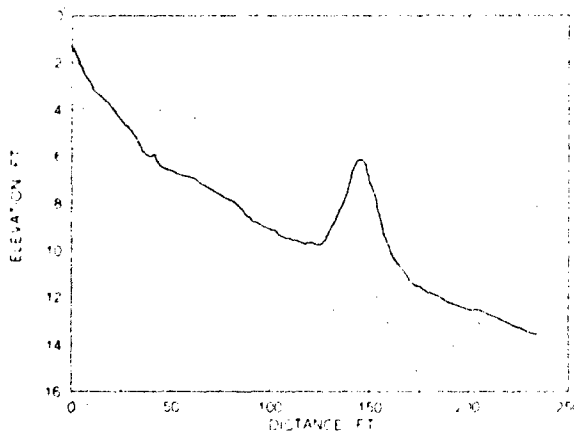


Figure 1. Initial profile of narrow-crested nearshore berm

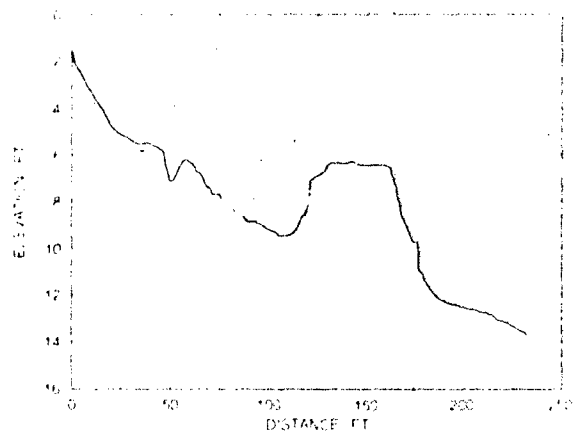


Figure 2. Initial profile of broad-crested nearshore berm

Table 1. Narrow-Crested Berm Tests

Run Number	Duration minutes	Period seconds	Wave Height meters	Wave Type
S0908A	60	Zeros for calibration (10 feet)		
S0911A	9	Zeros for calibration (10 feet)		
S0913A	20	3.0	0.7	Irregular
S0914A	20	3.0	0.7	Irregular
S0915A	40	3.0	0.7	Irregular
S0916A	70	3.0	0.7	Irregular
S0918A	70	3.0	0.7	Irregular
S1007A	9	Zeros for calibration (10 feet)		
S1008A	20	8.0	0.5	Irregular
S1008B	40	8.0	0.5	Irregular
S1009A	70	8.0	0.5	Irregular
S1011A	70	8.0	0.5	Irregular
S1013A	70	8.0	0.5	Irregular
S1014A	20	3.0	0.7	Regular
S1015A	20	3.0	0.7	Regular
S1015B	40	3.0	0.7	Regular
S1016A	70	3.0	0.7	Regular
S1018A	40	3.0	0.7	Regular
S1107A	9	Zeros for calibration (10 feet)		
S1107B	20	8.0	0.5	Regular
S1108A	40	8.0	0.5	Regular
S1109A	70	8.0	0.5	Regular
S1111A	70	8.0	0.5	Regular

Table 2. Broad-Crested Berm Tests

Run Number	Duration minutes	Period seconds	Wave Height meters	Wave Type
S1208A	9	Zeros for calibration (10 feet)		
S1208B	20	3.0	0.7	Irregular
S1209A	20	3.0	0.7	Irregular
S1209B	40	3.0	0.7	Irregular
S1210A	70	3.0	0.7	Irregular
S1212A	70	3.0	0.7	Irregular
S1214A	20	8.0	0.5	Irregular
S1215A	40	8.0	0.5	Irregular
S1216A	70	8.0	0.5	Irregular
S1217A	70	8.0	0.5	Irregular
S1307A	9	Zeros for calibration (10 feet)		
S1307B	20	3.0	0.7	Regular
S1308A	20	3.0	0.7	Regular
S1309A	40	3.0	0.7	Regular
S1310A	70	3.0	0.7	Regular
S1311A	40	3.0	0.7	Regular
S1313A	20	8.0	0.5	Regular
S1314A	40	8.0	0.5	Regular
S1315A	70	8.0	0.5	Regular
S1316A	70	8.0	0.5	Regular

attempted to replicate natural erosion and recovery periods. Wave sequencing was held constant for the narrow- and broad-crested berm tests. Current meters and wave gauges measured water surface displacement and vertical distribution of velocities across the profile to evaluate effects of the nearshore berm on hydrodynamics.

Because the waves rework the berm material and alter the berm profile, the same wave conditions could be tested over a variety of topography. Profiles of the subaerial and subaqueous region were taken at regular intervals throughout wave tests to document coincident beach and subaqueous berm evolution. This information can be used to evaluate the effects of hydrodynamics on the subaqueous berm and the beach, and the effects of the various topographies on the hydrodynamics.

Observations made at SUPERTANK indicate definite wave energy reduction with the berm in place, with longer waves being more affected by the broad-crested berm than by the narrow-crested berm. The waves quickly removed the upper 2 feet of the narrow berm, with each set of waves changing the berm profile shape. All profile shapes initiated wave breaking at the berm and provided protection to the beach. Reworking the broad-crested berm took more time. With the limited time available for testing, the crest elevation never changed for the broad-crested berm. However, waves reworked material on the offshore side of the broad-crested berm, and the crest width began to decrease.

Conclusions

From SUPERTANK tests, a comparison will be made between the wave, current, and profile data of an unprotected natural beach under wave attack and those of a beach protected by placement of a large subaqueous berm in the nearshore. Results of this experiment will aid in the design and evaluation of large subaqueous features placed in the nearshore region and in the development of models to simulate profile and hydrodynamic response to their presence.

References

Kraus, N. C., Smith, J. M., and Sollitt, C. K. 1992. "SUPERTANK Laboratory Data Collection Project," 23rd International Conference on Coastal Engineering, Venice, Italy, October 1992, American Society of Civil Engineers.

Kraus, N. C., and others. 1992. "SUPERTANK," Dredging Research Program Video, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

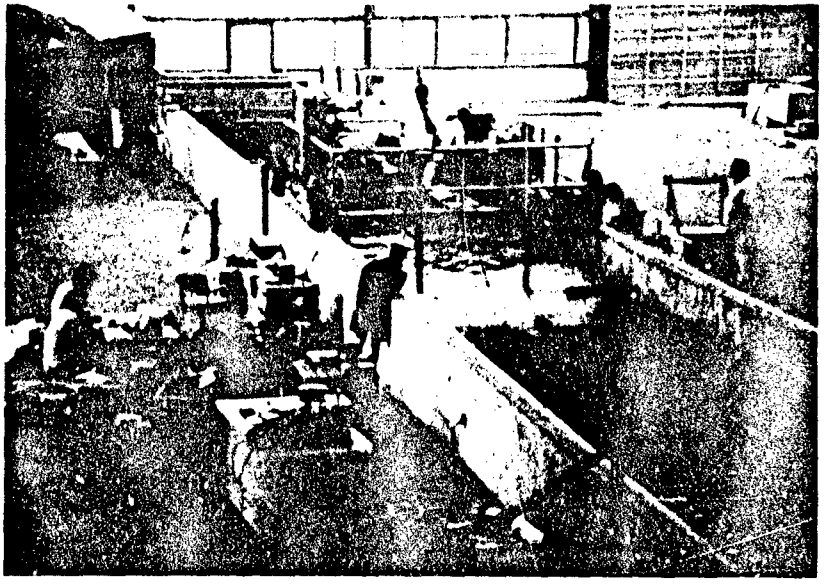
Cheryl Burke Pollock is a hydraulic engineer with the Coastal Structures and Evaluation Branch of the Coastal Engineering Research Center. Ms. Pollock graduated from Oregon State University with a Bachelor of Science degree in Civil Engineering. She is pursuing a Master of Science degree at Texas A&M University and is a member of ASCE and WEDA. Ms. Pollock has been involved principally in research pertaining to structure interaction with sediment movement, wave field alteration, and beach response. Additionally, Ms. Pollock is developing guidance for the design of nearshore berms.

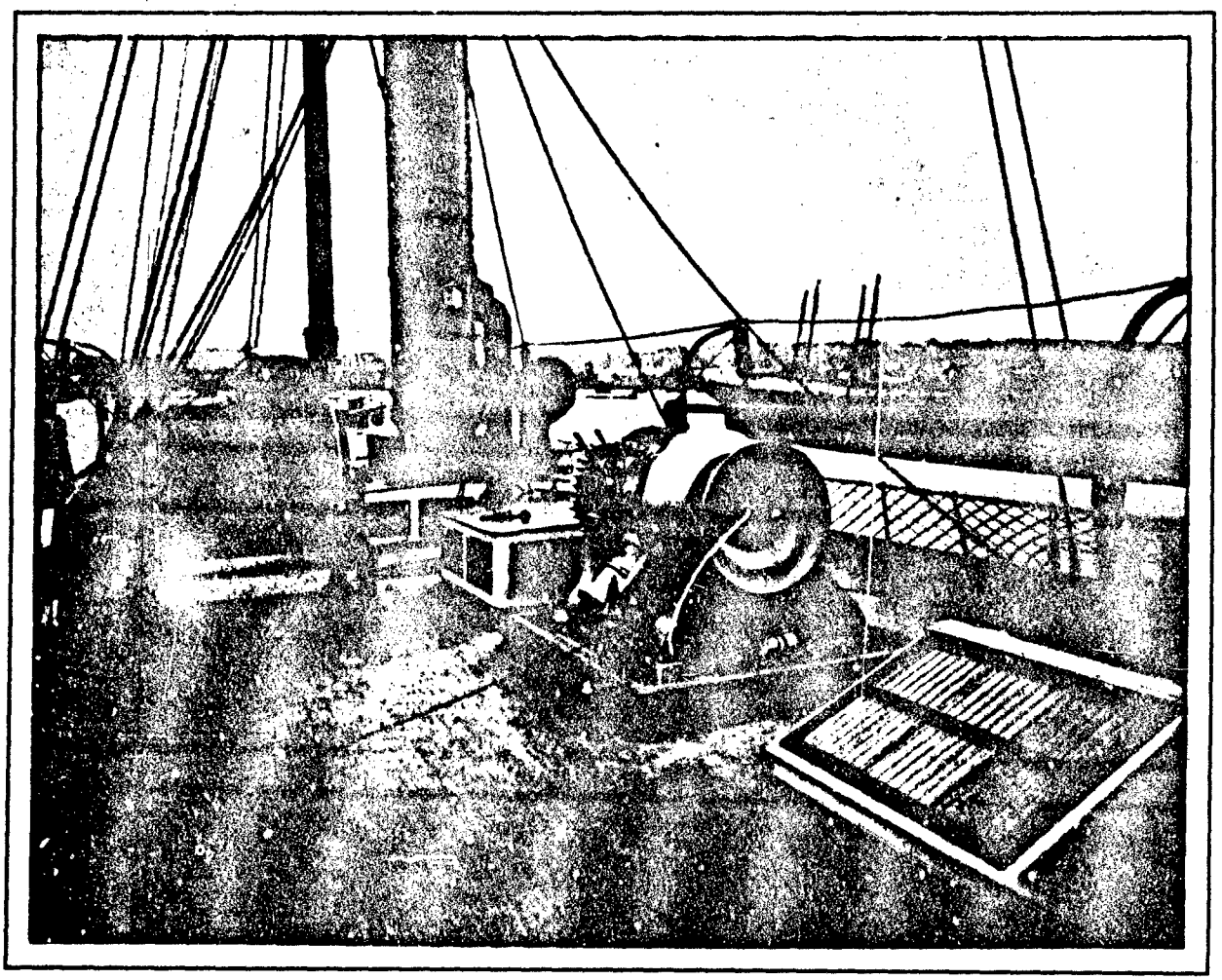
Have You Seen SUPERTANK?

A 20-minute video that documents the SUPERTANK experiments is available for your viewing. SUPERTANK, a major laboratory experiment performed at Oregon State University in 1991, obtained a comprehensive data set for use in understanding

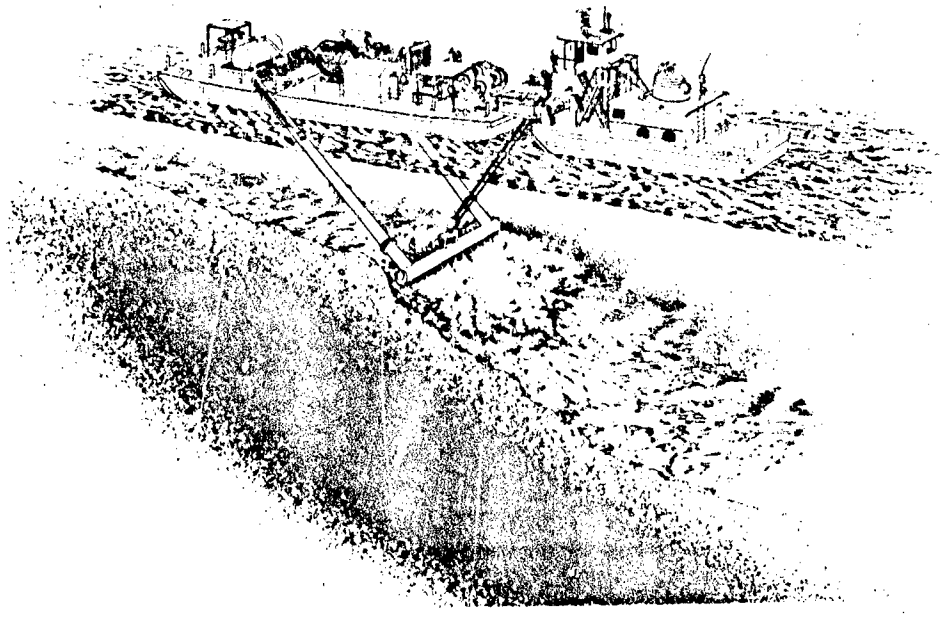
- Nearshore berm characteristics.
- Beach erosion and recovery.
- Surf zone waves and currents.
- Bottom boundary layer fluid and sediment transport processes.

Included in the video are descriptions and tentative results of the numerous tests performed in the 104-meter-long flume. To obtain a copy of this video, contact Russ Tillman at (601) 634-2016 or FAX (601) 634-4253.





The steamer *Blake*, ready for hydrographic surveying, circa 1880. This view shows the deck, looking aft from the starboard side of the pilot house. (Source: *Deep-Sea Sounding and Dredging* by Charles D. Sigsbee, U.S. Coast and Geodetic Survey.) Submitted by Norm Scheffner, Coastal Engineering Research Center



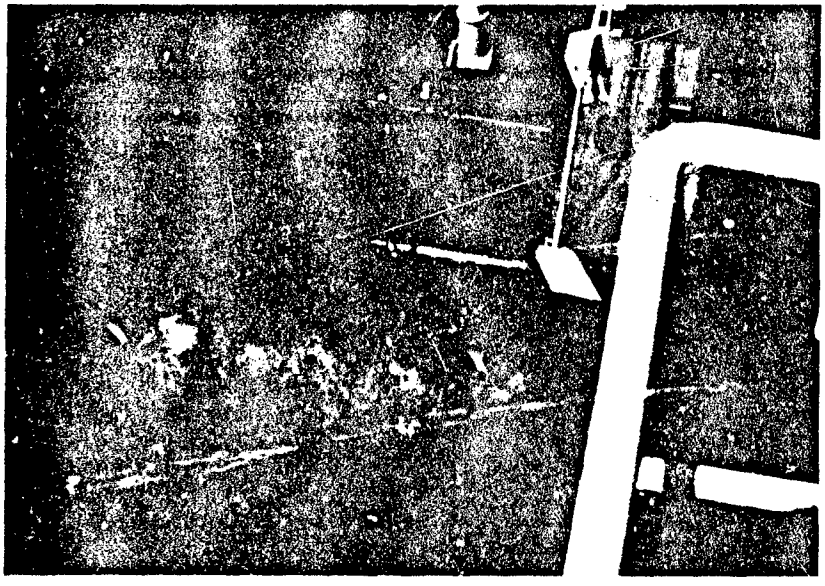
Two demonstrations were recently held on the upper Mississippi River to test the effectiveness of water injection dredging

DRP site visit:

Water injection dredging

by
Anne-Marie Murphy

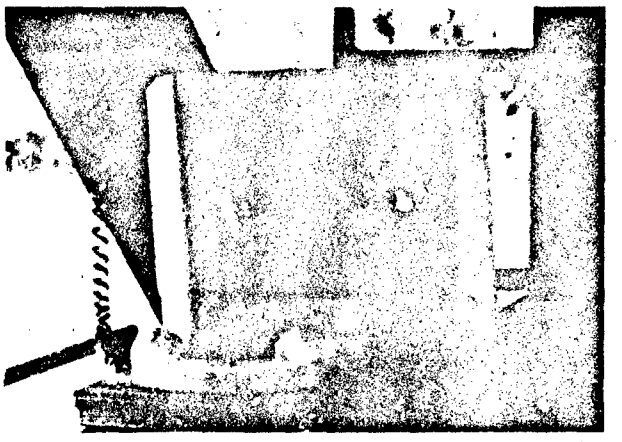
An innovative technique, water injection dredging, has been introduced at three Corps Districts. Water injection dredging (WID) is relatively unknown in the United States, although it has been used successfully in Europe for several years. Senior Corps staff visited Europe in 1990 and were impressed with this concept. As a result, the Corps has recently begun investigating the applicability of this technique to its maintenance dredging operations.



Water injection pipe with jets

To find out how useful this system would be when applied in North American conditions, the Corps contracted with Gulf Coast Trailing Company, Inc., and HAM (the Dutch dredging firm that owns the rights to the technology) to conduct two demonstrations of their water injection dredge vessel on the Mississippi River. The first of these efforts

Corps personnel discussing water injection dredge operation aboard vessel



Positioning system used by the dredge team

was conducted at a New Orleans, Louisiana, site, in late June 1992.

WID is based on a very simple concept: a pipe is lowered to the bottom of the harbor or channel, where vessel-mounted pumps provide high-volume jets of water that penetrate the sediment. Unlike agitation dredging, the injected water fluidizes the sediment, which in turn creates a density current that transports the dredged sediment to a desired placement site. The process uses the natural action of the river but, in addition, resuspends the sediment so that nature can carry it farther than before. WID eliminates the need to actively transport the dredged material to a placement site, as with a pipeline or other conventional dredge, and the dredging equipment is simple to operate with minimal crew or other support. This means that, in many cases, WID offers a potentially low-cost alternative to traditional dredging methods.

Representatives of the Corps' Lower Mississippi Valley Division and the Galveston, Mobile, and New Orleans Districts toured the dredge vessel and were given the opportunity to ask questions about its operation and feasibility, both during and after the demonstration run. The demonstration lasted approximately three hours, during which a test section of the river was dredged.

In addition to viewing the dredge, the visitors were shown the positioning system used by the operator. Housed in the bridge of the accompanying pushboat, the system presents a real-time "map" of the dredging area and gives the locations of the vessel and the injection pipe. Also, data are collected with each pass, and are later evaluated.

After the dredge completed its run, the group attended a briefing conducted by Mr. Paul Verpalen, the HAM contractor. Technical and financial facets of WID were discussed in a short visual presentation, followed by a question-and-answer session.

The initial demonstration set the stage for in-depth tests that were conducted at a St. Paul District site on the upper Mississippi River, near Fountain City, Wisconsin, in late July 1992 and at a Rock Island District site near Savanna, IL, in early August 1992. During this demonstration, a Dredging Research Program (DRP) team monitored various water column and sediment characteristics before, during, and after dredging, and compared actual water injection performance with contractor predictions. These observations will be reported in a DRP Technical Report and Video.

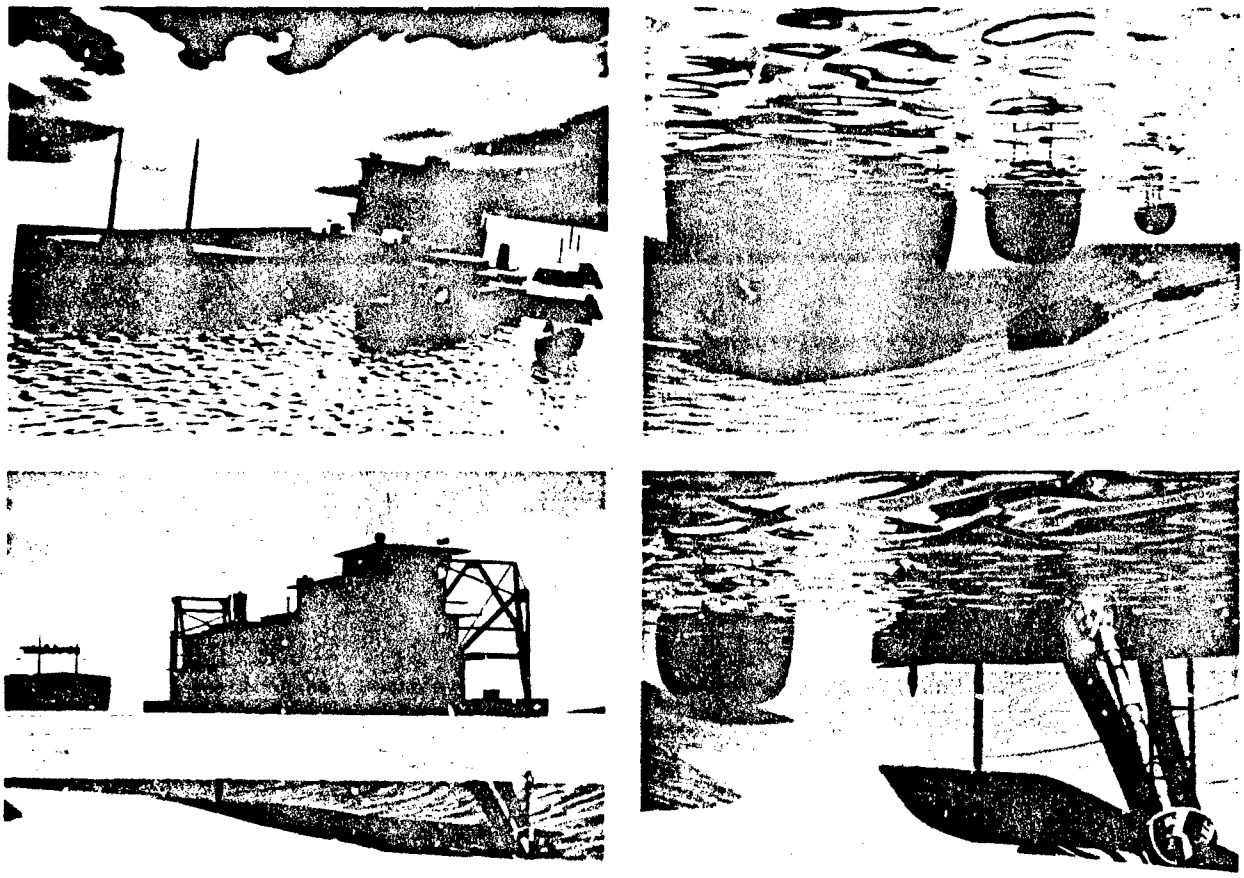
For more information concerning WID, contact James E. Clausner at (601) 634-2009, or the DRP program manager, E. Clark McNair at (601) 634-2070.

Anne-Marie Murphy, a contract student working in the Coastal Engineering Research Center for the Dredging Research Program, is a sophomore at the University of New Orleans studying for a Bachelor of Arts degree in English (professional writing). Murphy is a member of the University Honors Program and is a National Dean's List Scholar.

America's Ports and Waterways — New video released

The Corps' Dredging and Navigation Branch and the American Association of Port Authorities have prepared a new video titled *America's Ports and Waterways: Open Channels to Trade*. This eight-minute video communicates the importance of ports to the U.S. economy and national security, and the necessity of constructing and maintaining open navigation channels.

This video is ideal for viewing by audiences that are not familiar with the need for dredging. Included in the video is a brief discussion of the beneficial uses of dredged material. If you would like to obtain a copy of this video, contact Russ Tillman at (601) 634-2016 or FAX (601) 634-4253.

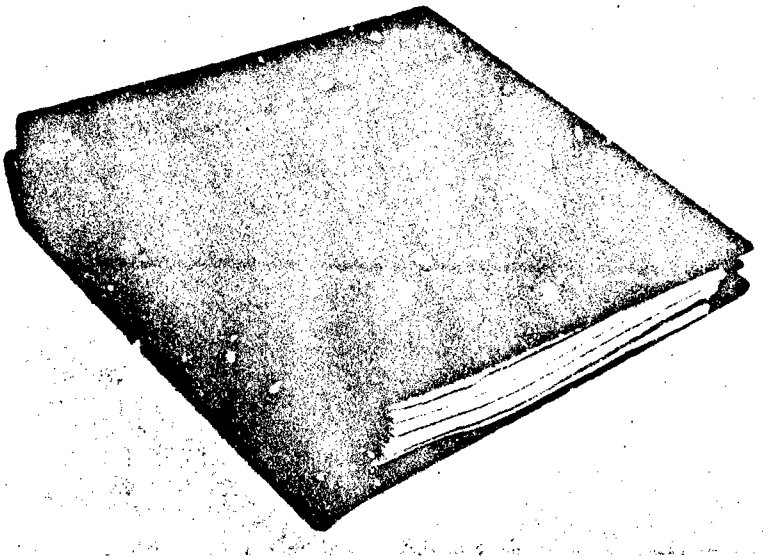


America's Ports and Waterways: Open Channels to Trade **includes state-of-the-art animation that depicts dredging operations and the increase in the draft of ships using waterways**

DRP Technical Note series available

Do you receive Dredging Research Program Technical Notes? If not, you may be missing one of the quickest ways to learn of DRP research results. Technical notes are designed to rapidly relay research results to DRP users. Technical notes are short (5 to 10 pages) loose-leaf documents that describe some facet of DRP work. They are categorized by the five DRP Technical Areas, to provide interim products, methodologies, and guidance to DRP users when normal distribution of the results would not occur until later, when published in a formal and more detailed technical report. To date, 35 DRP technical notes have been published. Examples of topics addressed in DRP Technical Notes are

- Methods to predict cross-shore movement of dredged material berms.
- Results of controlled tests of eductors and submersible pumps.
- Procedure for using a point load tester for dredging application.
- Results of laboratory tests on dredging production meters.
- Design requirements, site selection, and monitoring considerations for capping.
- Information guide to the DRP.



DRP Technical Note series notebook

If you would like to obtain a complete set of DRP Technical Notes and be placed on the distribution list to receive future issues, contact:

Commander, U.S. Army
Engineer Waterways
Experiment Station
ATTN: CEWES-CP-D/
Russ Tillman
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
Telephone: (601) 634-2016
Facsimile: (601) 634-4253

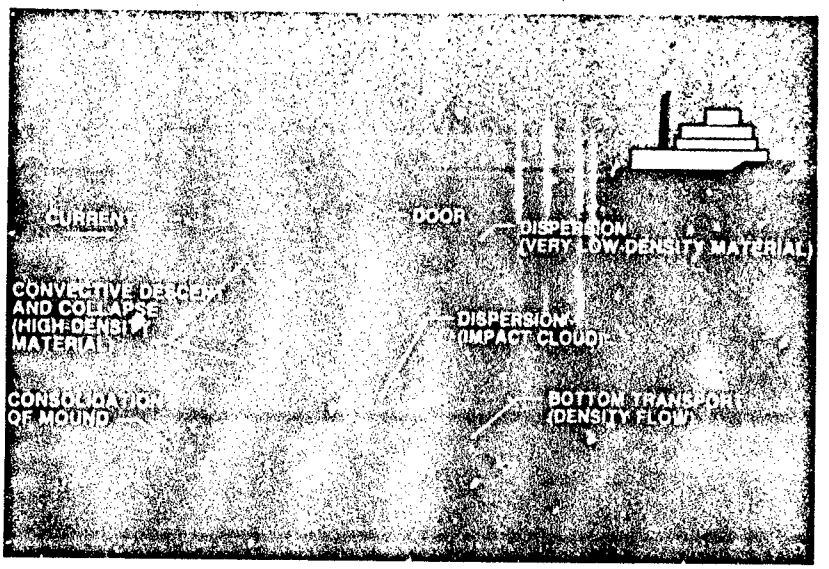
Calendar of dredging-related events

April 6-7, 1993	**Dredging Research Program Field Review Group Meeting**, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, POC: Clark McNair, (601) 634-2070.
April 7-8, 1993	**Dredging Operations Technical Support and Long-Term Effects of Dredging Operations Field Review Group Meeting**, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, POC: Tom Patin, (601) 634-3444.
May 26-28, 1993	**Western Dredging Association 14th Annual Meeting and Technical Conference/26th Texas A&M University Annual Dredging Seminar**, Caesar's, Atlantic City, NJ, POC: (WEDA) Larry Patella, (503) 224-9087; (TAMU) John Herbich, (409) 845-4517.
June 7-11, 1993	**DRP Sediment Transport Modeling and Monitoring Workshop**, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, POC: Dr. Nicholas Kraus, (601) 634-2018.

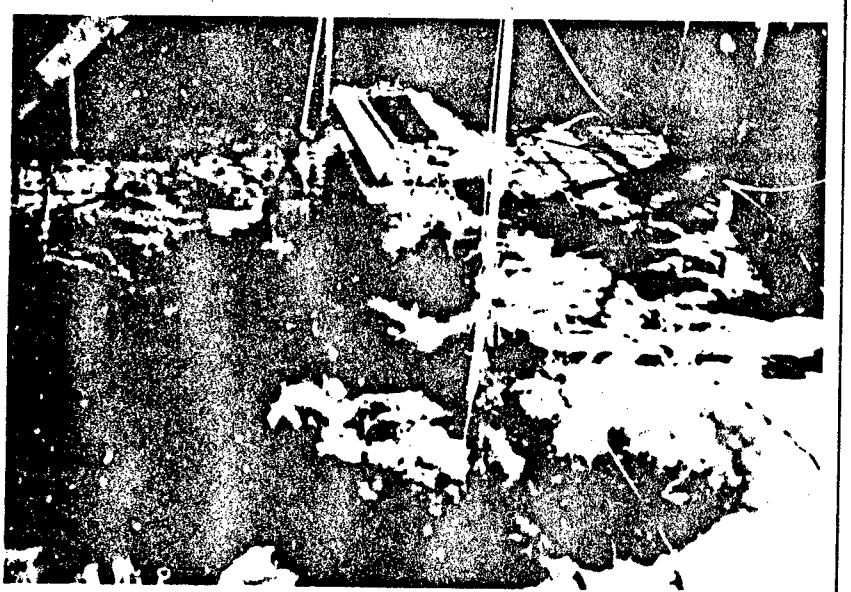
DRP Technical Area 1 workshop scheduled

DRP Technical Area 1 (Analysis of Dredged Material Placed in Open Water) is sponsoring a workshop entitled "Modeling, Monitoring, and Measurement." The workshop will present information on the state-of-the-art capabilities and DRP products for sediment transport and hydrodynamics modeling and measurement.

This workshop will provide an opportunity for hands-on training in a variety of PC models used to calculate nearshore berm movement, dredged material disposal (short-term fate model), movement of sediment on the sea bottom (long-term fate model), longshore current and sand transport over nearshore berms, cohesive material properties and transport, and other physical processes of interest in dredging operations that take place in open water. In addition, orientation and training will be given on measurement technology, such as the Plume Measurement System, and cost-effective monitoring methods, including example case studies of berm movement and sediment plume tracking.



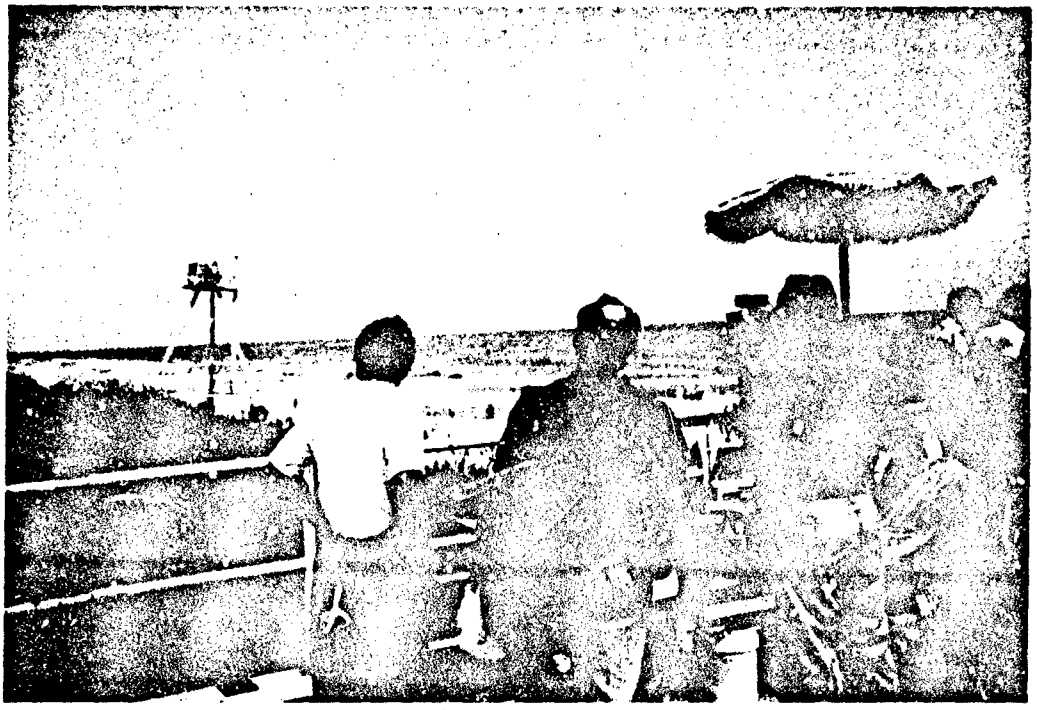
DRP models are being developed for predicting short- and long-term effects of dredged material placed in open water



Physical model testing facility, developed by the DRP, to simulate dredged material placement activities

The workshop will be conducted on June 7-11, 1993, at the U.S. Army Engineer Waterways Experiment Station. Plans are to conduct the workshop in two parallel sessions, to allow participants to focus on technology of most importance to them and to provide time for individual instruction in exercising of the models. A preliminary schedule of workshop subjects will be available in February 1993.

Attendance at the workshop will be limited, and reservations will be taken on a first-come basis. For further information and to reserve a position, please call Peggy Brown, CEWES-CV-CS, at (601) 634-4036 or FAX (601) 634-4314.



Workshop participants viewed a positioning demonstration that compared location reports from the Coastal Research Amphibious Buggy mounted with a GPS receiver and from a Geodimeter mounted on the pier

Workshop on DRP GPS held

Over seventy participants attended one of two workshops that presented an overview of the global positioning satellite (GPS) concept and the capabilities and requirements for the DRP decimeter GPS system. The workshop was conducted at the CERC Field Research Facility (FRF) at Duck, North Carolina. Participants were briefed on the new GPS system being developed under the DRP and viewed demonstrations of the On-the-Fly GPS decimeter positioning capabilities (postprocessed). Also included were explanations of basic GPS technology and the implementation requirements, estimated cost, and availability date of the system being developed by the DRP. A joint positioning demonstration was performed using the FRF Coastal Research Amphibious Buggy (CRAB) mounted with a GPS receiver and a Geodimeter mounted on the FRF pier. Postprocessing results from the CRAB GPS meter were compared with the pier-mounted Geodimeter for position accuracy.

To learn more about the DRP GPS decimeter system, contact Sally Frodge, U.S. Army Topographic Engineering Center (CETEC-TL-SP), (703) 355-2819.

Chief of Engineers' charge to the Coastal Engineering Research Board (CERB)

At the October meeting of the CERB, LTG Arthur E. Williams, Chief of Engineers, gave a charge to the Board. The previous Chief's charge, which was given by LTG E. R. Heiberg III in 1985, focused the Board's attention on a number of areas and was the catalyst for several events, including initiation of the Dredging Research Program.

In LTG Williams' charge of October 27, 1992 (reproduced below), he was highly complimentary of the DRP and asked the Board to recommend ways of continuing some activities.

Good morning and welcome to the 57th meeting of the Coastal Engineering Research Board. I regret that I am unable to personally be with you today in beautiful Honolulu, but I want to use this videotape to reaffirm my commitment to the work of the Board and continue to recognize the unique relationship between the Corps of Engineers and the coastal engineering community. I believe it's fair to say that to a large degree this Board speaks for, and is the principal proponent for, coastal engineering in the United States and perhaps even the world. We, in the Corps, take seriously the recommendations of this Board since the recommendations reflect the professional opinions of three of the top coastal engineering experts coupled with the vast experience and deep understanding of issues from our military members.

The devastating storms that hit Hawaii and Guam, and Hurricane Andrew remind us of the importance of our roles on the Board. Decisions and recommendations made by this Board affect major policy decisions on the protection of valued property and, more importantly, on the protection of invaluable life.

I want to take this opportunity to provide you my thoughts and guidance, and to be more formal, this is my Charge to the CERB. You will find in your notebooks a more in-depth version of the Charge with five specific areas, and I ask you to carefully consider these. My desire today is to briefly talk about each area and give you a better idea of my philosophy in this important field for which we speak.

The first area is education and training. In General Heiberg's Charge, he said we must "grow our own." He was talking about growing our own coastal specialists. Now we have shown we can successfully do this through the Coastal Engineering Education Program. As successful as this program is, there are always ways to improve it and to seek other avenues to reach even more of our coastal specialists. One group, as General Yankoupe has reminded us, is our coastal construction specialists. So, the question I would ask you is, "What are the avenues we should pursue in this issue?"

The second area is environment. From the outset, I want to reaffirm the Corps' and my personal commitment to performing our mission in an environmentally sustainable manner. To do this, we must ensure that all the activities are governed by a comprehensive and holistic approach.

To assess environmental risks in a holistic manner, we must understand the physical processes involved in order to consider the potential threat or exposure and the resulting impact. In the coastal zone, it is CERC's, and, consequently, this Board's mission to ensure that technology is available to understand these physical processes. Through the Dredging Research Program and other research programs, we are now doing a great job with physical processes, and have gained credibility from EPA and other groups and agencies. I want the CERB to continue to provide the oversight that has been so valuable in establishing our credibility. I also want you to recommend other areas where the partnerships between the environmental and coastal communities can demonstrate our clear commitment to the quality of our environment.

Now, the third area is technology transfer. I have been very impressed by the videos and other technology transfer efforts of the DRP. I believe we owe the taxpayers the courtesy of letting them know how their money is being used. We are conducting world-class research that I believe would be of great interest to many, including the young people who may find they want to go into this exciting field. I ask that you look at methods and resources for reaching these varied audiences.

I also ask that you look for funding sources for developing the Coastal Engineering Manual. This manual will replace the ***Shore Protection Manual****, which has been the "bible" of coastal engineering. In our role as the principal proponent and advocate for coastal engineering, we must see that our professionals have the latest guidance.*

Now, the fourth area is funding. I am sure you are not surprised this is an area I want you to delve into. Our R&D system works! All we have to do is find the funding to allow the process to work.

Our General Investigations Research and Development program continues to decline. However, people such as John Elmore who manages the Corps' Operations and Maintenance budget have recognized the need and have funded R&D to more effectively conduct his work.

So, the question is, "What other funding sources are there?" And I ask you help us develop a funding strategy.

My final area is programs. I charge you to continue to provide a critical review of all our programs and activities in the coastal zone. The civilian members should continue to participate in the Field Review Group meetings. The military members know firsthand what the problems are. I want to know from you if our programs are meeting your needs.

The CERB must continue to look into the future and provide a long-range, broad look at coastal engineering needs. Remember, now you play a very vital role in keeping the whole discipline healthy. You have an awesome responsibility and a tremendous opportunity to make significant contributions, and I look forward to your ideas and recommendations. ALOHA! Have a good meeting and enjoy Honolulu!

Environment Canada initiates contaminated sediments removal demonstrations

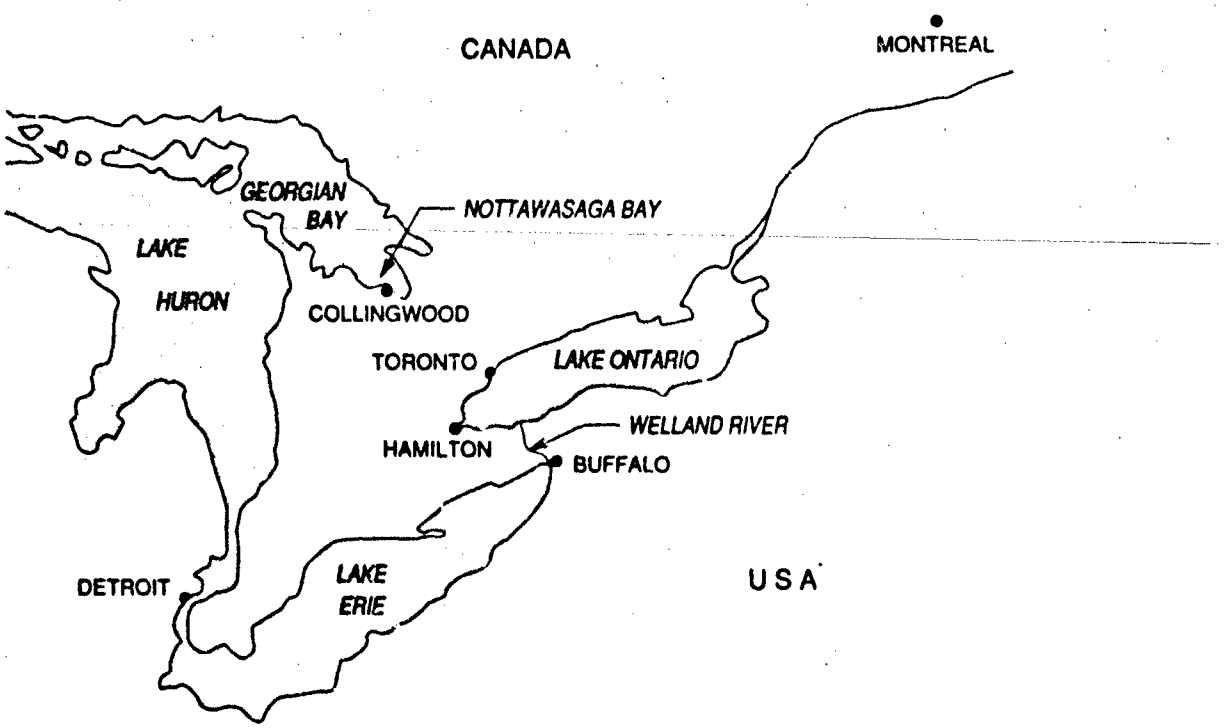
Environment Canada has initiated a number of activities related to the assessment and remediation of contaminated sediments in areas of concern in the Great Lakes. The major thrust of these activities comes from the Great Lakes Action Plan.

Environmental Protection is the lead agency in Environment Canada for federal programs researching removal and treatment technologies related to contaminated sediments in these areas of concern. Three sediment programs have been established under the Cleanup Fund to address the issues of contaminated sediments: the Contaminated Sediment Removal Program (CSRP), the Contaminated Sediment Treatment Technology Program, and the Contaminated Sediment Assessment Program. A significant portion of the Cleanup Fund has been allocated to developing and demonstrating technology for the assessment, removal, and treatment of contaminated sediments under these programs.

The Great Lakes Cleanup Fund focuses on areas of concern having documented areas of sediment contamination for which one remediation option would be removal and treatment of the contaminated material. These zones of contamination could be termed "hot spots" because the concentrations of contamination pose a threat to the health of the ecosystem. These areas also represent the most immediate sediment contamination problems in the Great Lakes and, for the purposes of technology demonstration, are geographically diverse.

Demonstrations have been conducted at Welland River, Toronto and Hamilton Harbors (both on Lake Ontario), and at Collingwood Harbor (on Nottawasaga Bay of Lake Huron) by various companies using different equipment types and different removal and treatment technologies. The DRP and DOTS programs have been observing these demonstrations and hope to publish a summary of Environment Canada's results in future issues of *Dredging Research*.

For further information on the Cleanup Fund and the CSRP, contact Ian Orchard at (416) 973-1089.



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ROBERT W. WHALIN, PhD, PE
Director